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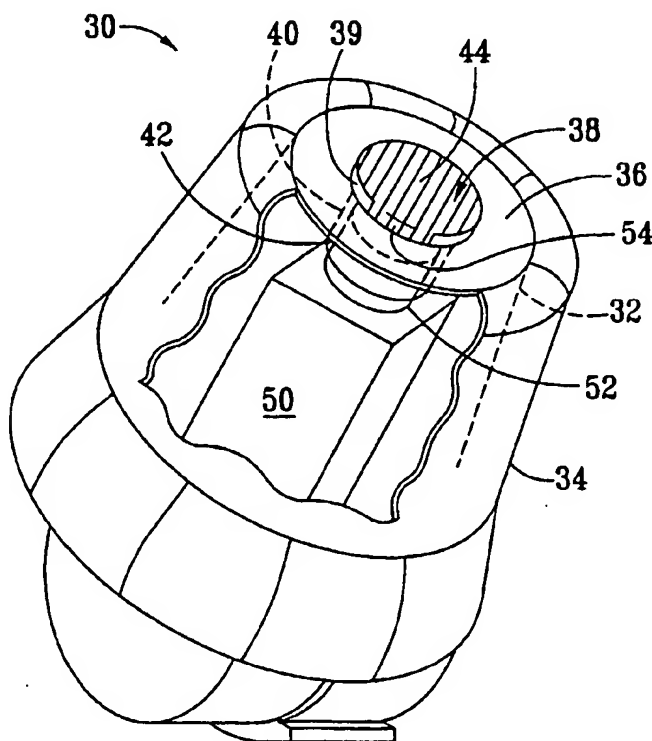
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- (72) Inventors: BRIMHALL, Owen, D.; 11217 South Crescentridge Circle, South Jordan, UT 84095 (US). ELLIS, Carl, E.; 3790 South 1950 East, Salt Lake City, UT 84106 For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: RECEIVER SUSPENSION DEVICE FOR AN IN-THE-CANAL HEARING AID



(57) Abstract: An In-The-Canal hearing device (30) includes a flexible receiver suspension grommet (40) seated in the sound port (38) of the receiver housing (32) of a hearing device. The suspension member (40) includes a tubular portion (42) extending into the receiver housing, the tubular portion configured to retain a receiver unit in a position such that sound waves emitted from the receiver unit are directed through the sound port. The proximal portion of the receiver unit is suspended gently away from the receiver housing walls by a thin membrane skirt. The membrane skirt is formed from an initially flat membrane, which is then stretched over the receiver unit, forming gentle pleats that help suspend the receiver unit in the receiver housing, isolating it from contact and/or vibrations from the housing walls.

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## SPECIFICATION

## RECEIVER SUSPENSION DEVICE FOR AN IN-THE-CANAL HEARING AID

## RELATED APPLICATION DATA

5        This patent application is a continuation-in-part of co-pending U.S. application serial no. 09/317,485, filed on May 24, 1999, which is fully incorporated herein by reference.

## FIELD OF THE INVENTION

10       The present invention pertains to hearing aids. More particularly, the present invention pertains to cerumen guards and receiver assemblies for use in hearing devices.

## BACKGROUND OF THE INVENTION

15       The modern trend in the design and implementation of hearing devices is focusing to a large extent on reducing the physical size of the hearing device. Miniaturization of hearing device components is becoming increasingly feasible with rapid technological advances in the fields of power supplies, sound processing electronics and micro-mechanics. The demand for smaller and less conspicuous hearing devices continues to increase as a larger portion of our population ages and faces hearing loss. Those who face  
20       hearing loss also encounter the accompanying desire to avoid the stigma and self consciousness associated with this condition. As a result, smaller hearing devices which are cosmetically less visible are increasingly sought after.

      Hearing device technology has progressed rapidly in recent years. First generation hearing devices were primarily of the Behind-The-Ear (BTE) type, where an externally  
25       mounted device was connected by an acoustic tube to a molded shell placed within the ear. With the advancement of component miniaturization, modern hearing devices rarely use this Behind-The-Ear technique, focusing primarily on one of several forms of an In-The-Canal (ITC) hearing device.

      Three main types of ITC hearing devices are offered by audiologists and  
30       physicians. In-The-Ear (ITE) devices rest primarily in the concha of the ear and have the disadvantages of being fairly conspicuous to a bystander and relatively bulky to wear. Smaller ITC devices fit partially in the concha and partially in the ear canal and are less visible but still leave a substantial portion of the hearing device exposed. Recently,

Completely-In-The-Canal (CIC) hearing devices have come into greater use. As the name implicates, these devices fit deep within the ear canal and are essentially hidden from view from the outside.

In addition to the obvious cosmetic advantages these types of in-the-canal devices provide, they also have several performance advantages that larger, externally mounted devices do not offer. Placing the hearing device deep within the ear canal and proximate to the tympanic membrane (ear drum) improves the frequency response of the device, reduces distortion due to jaw extrusion, reduces the occurrence of the occlusion effect and improves overall sound fidelity.

It is desirable, therefore, to provide an in-the-canal hearing device with the best possible sound amplification quality.

#### SUMMARY OF THE INVENTION

The present invention provides a receiver suspension member seated in the sound port of the receiver housing of an in-the-canal hearing device.

In a preferred embodiment, the suspension member is a flexible grommet, including a tubular portion extending into the receiver housing. The tubular portion of the grommet is configured to retain a receiver unit in a position such that sound waves emitted from the receiver unit are directed through the sound port.

In accordance with a further aspect of the invention, the back (i.e., proximal) portion of the receiver unit is suspended gently away from the receiver housing walls by a thin membrane skirt. The membrane skirt is preferably elastomeric, and may be formed from an initially flat membrane, which is then stretched over the receiver unit, forming gentle pleats that help suspend the receiver unit in the receiver housing, isolating it from contact and/or vibrations from the housing walls.

Other and further aspects and advantages of the invention will become apparent hereinafter.

## BRIEF DESCRIPTION OF THE DRAWINGS

The drawings illustrate both the design and utility of the preferred embodiments of the present invention, in which similar elements in different embodiments are referred to by the same reference numbers for purposes of ease in illustration of the invention,

5 wherein:

Fig. 1 is a preferred in-the-canal hearing device having a combined receiver suspension grommet and cerumen guard device seated in a sound port of its receiver housing;

10 Fig. 2 is a cut-away side view of the distal end of the receiver housing of Fig. 3, further illustrating the combined receiver suspension and cerumen guard device, with the cerumen guard shown in a closed position;

Fig. 3 depicts cerumen guard of Fig. 3 in an open position, e.g., for cleaning; and

Fig. 4 depicts an alternate preferred in-the-canal hearing device utilizing a receiver suspension grommet and isolating membrane skirt.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to Fig. 1, a preferred ITC hearing device 30 includes a receiver housing 32 substantially enclosed in a conformal jacket 34. As disclosed and described in U.S. Patent Application Serial No. 09/231,282, which is hereby fully incorporated by reference, the conformal jacket 34 facilitates the positioning of the hearing device 30 within a wearer's ear canal (10). In particular, the conformal jacket 34 forms an acoustic seal between a distal end 36 of the receiver housing 32, which is positioned proximate the wearer's tympanic membrane (16), and the outer ear (17) of the wearer. A sound port (i.e., an aperture) 38 is provided in the distal end 36 of the receiver housing 32.

In accordance with one aspect of the invention, a flexible, cylindrical grommet 40 is snugly seated in the sound port 38. As best seen in Figs. 2 and 3, the grommet 40 is retained by a circular rim 46 of the receiver housing 32, which defines the sound port 38. The grommet 40 comprises a receiver suspension tube 42, which extends into the receiver housing 32. A cylindrical neck portion 52 of a receiver unit 50 is retained by the suspension tube 42, such that sound waves emitted from an audio speaker (not shown) within the receiver unit 50 are directed through the sound port 38. The suspension tube 42 also functions to isolate any vibration of the receiver 50 from the receiver housing 32. In particular, the general flexibility of the grommet 40 provides vibration isolation between the receiver 50 and the receiver housing 32.

In accordance with a further aspect of the invention, a cover piece 44 is "hingedly" attached to the grommet 40, and is sized to substantially cover the sound port 38, thereby functioning as a cerumen guard. In a preferred embodiment, the grommet 40 is preferably made of a flexible elastomeric material, such as rubber or silicon, with the cover piece 44 integrally molded with the rest of the grommet 40 as a single piece construction. One advantage of such material is that the cover piece 44 will be relatively compliant, easing insertion into a sensitive ear canal (10).

As best seen in Figs. 1 and 3, the cover piece 44 is attached by an arcuate extension portion 54 of the grommet 40 proximate the circular rim 46 of the sound port 38. The extension portion 54 is preferably sized such that, taking into account the particular strength and flexibility of the grommet material, the cover piece 44 can be placed in either a closed (Fig. 2), or open (Fig. 3) position. In particular, as indicated by arrow 56 in Fig. 5, the cover piece 44 pivots about flexible extension portion 54 at the rim 46 of the sound

port 38. The compliant material forming the grommet 40 also facilitates the movement of the cover piece 44 about the extension portion 54 of the grommet 40.

In alternate embodiments, the cover piece 44 and grommet 40 may be made of two or more separate pieces, which are bonded together in a way which still allows for the flexible pivoting of the cover piece 44 relative to the circular rim 46 of the sound port 38. Thus, as used herein, the term "hingedly" means that the cover piece 44 may be "pivoted" about the extension portion 54 of the grommet 40 akin to a door being pivoted about its hinges. It is not necessary that there be actual hinges or pins, etc., which attach the cover piece 44 to the grommet 40, although this is also contemplated by the term "hingedly".

In still further embodiments, the cover piece 44 may be completely removable from the grommet 40, e.g., in a "snap-on" configuration.

The cover piece 44 is fashioned with a positioning lip 48, which extends towards the receiver housing 32 from an outer circumferential edge of the cover 44. As seen in Fig. 2, when the cover piece 44 is in a closed position, the positioning lip 48 biases the cover piece 44 slightly away from the sound port 38, providing an annular opening 39 around much of the circular rim 46 of the sound port 38 (i.e., except where the lip 48 and attaching portion 54 are located). The flexible material forming the grommet 40 will allow the cover piece 44 to be easily bent open for cleaning of entrapped cerumen, while being resilient enough to provide a natural biasing to automatically return the cover piece 44 to a closed (i.e., operating) position.

On insertion into a wearer's ear canal, the cover piece 44 will tend to collapse shut when pressed against the ear canal wall, hence preventing the receiver port 38 from scooping cerumen at the rim 46. The resilience of the positioning lip 48 functions to automatically reopen the sound port 38 after insertion.

Referring to Fig. 4, an alternate preferred ITC hearing device 80, which is disclosed and described in great detail in co-pending U.S. patent application serial no. [not-yet-assigned; Lyon & Lyon Docket 247/154], filed on the same day herewith, includes a receiver housing 82. The receiver housing 82 comprises a thin outer wall 84 having a distal end sound port opening 86. A receiver unit 92 is suspended by a flexible, cylindrical grommet 88, which is snugly seated in the sound port 86.

In particular, the suspension grommet 88 includes a tubular portion 89 that extends into the receiver housing 82. A cylindrical neck portion 90 of the receiver unit 92 is retained by the tubular portion 89, such that sound waves emitted from an audio speaker

(not shown) within the receiver unit 92 are directed out the sound port 86. The tubular portion 89 of the suspension grommet 88 also functions to isolate any vibration of the receiver unit 92 from the receiver housing 82. Further the general flexibility of the suspension grommet 88 provides vibration isolation between the receiver unit 92 and the receiver housing 82 (i.e., like a shock absorber).

In accordance with a further aspect of the invention, the back (i.e., proximal) portion of the receiver unit 92 is suspended gently away from the receiver housing walls 84 by a thin membrane skirt 94. The membrane skirt 94 is preferably elastomeric, and may be formed from an initially flat membrane, which is then stretched over the receiver unit 82. Once stretched over the receiver unit 92 body, the membrane skirt 94 forms gentle pleats that help suspend the receiver unit 92 in the receiver housing 82, isolating it from contact and/or vibrations from the housing walls 84.

Further details regarding the hearing device 80 are provided in the above-referenced U.S. application serial no. [not-yet-assigned; Lyon & Lyon Docket 247/154], which is hereby fully incorporated by reference for all it discloses and teaches.

Although the invention has been described and illustrated in the above description and drawings, it is understood that this description is by example only and that numerous changes and modifications can be made by those skilled in the art without departing from the true spirit and scope of the invention.

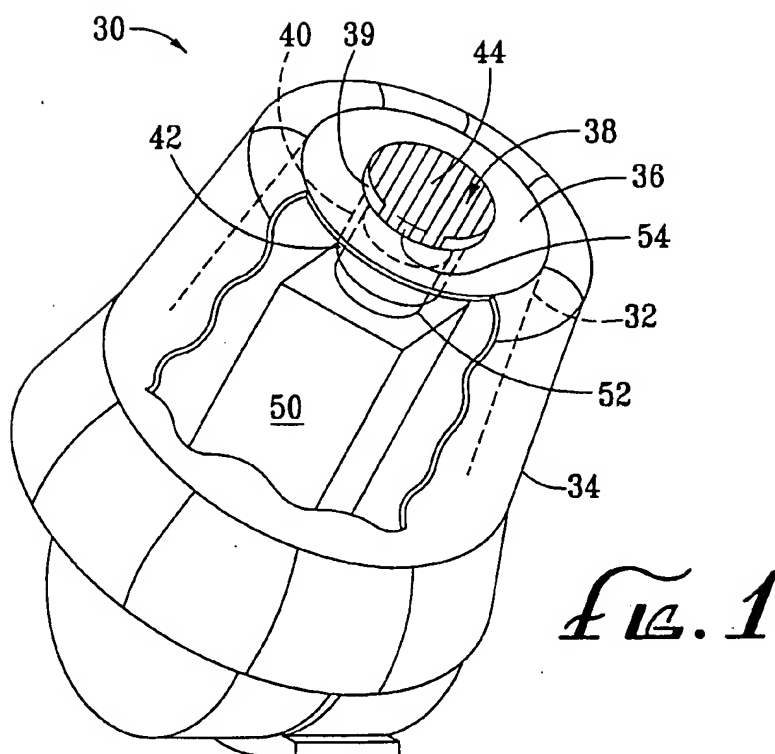
The invention, therefore, should not be restricted, except by the following claims and their equivalents.

What is claimed is:

1. A hearing device, comprising:  
a housing having a sound port; and  
a suspension member seated in the sound port and configured to retain a receiver  
5 unit in a position such that sound waves emitted from the receiver unit are directed  
through the sound port.
2. The hearing device of claim 1, wherein the suspension member is a flexible  
grommet.
- 10 3. The hearing device of claim 2, wherein the grommet comprises a tubular portion  
extending into the receiver housing, the tubular portion configured to snugly retain the  
receiver unit.
- 15 4. The hearing device of claim 2, further comprising an isolating member  
substantially surrounding the receiver unit, the isolating member substantially isolating the  
receiver unit from contact or vibrations from the receiver housing.
- 20 5. A hearing device, comprising:  
a receiver housing having a wall;  
a sound port formed in the receiver housing wall;  
a suspension member seated in the sound port, the suspension member including a  
portion extending into the housing;  
a receiver unit retained by the suspension member in a position such that sound  
25 waves emitted from the receiver unit are directed through the sound port; and  
a isolating member substantially surrounding the receiver unit, the isolating  
member substantially isolating the receiver unit from contact or vibrations from the  
receiver housing wall.
- 30 6. The hearing device of claim 5, wherein the suspension member is a flexible  
grommet.

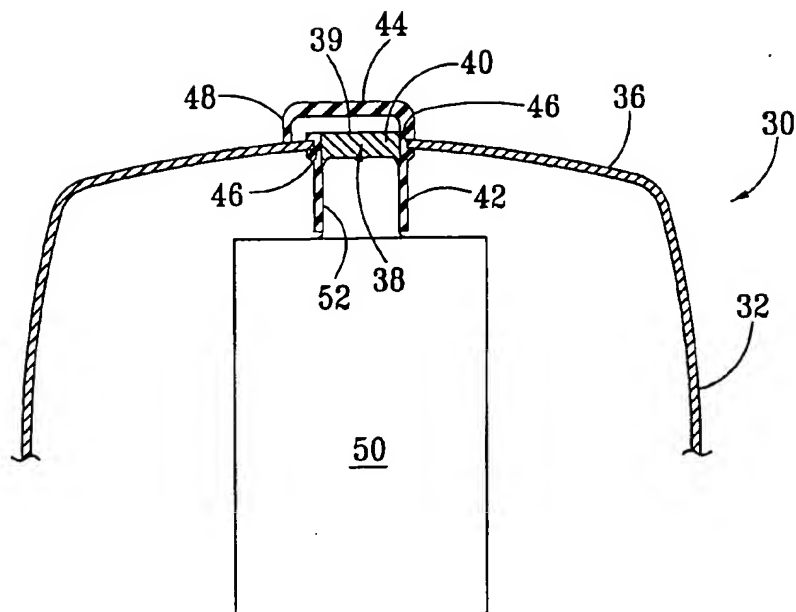


7. The hearing device of claim 5, wherein the isolating member comprises a substantially thin membrane.
8. The hearing device of claim 7, wherein the membrane forms pleads to help isolate  
5 and suspend the receiver unit within the receiver housing.
9. The hearing device of claim 7, wherein the membrane is elastomeric.

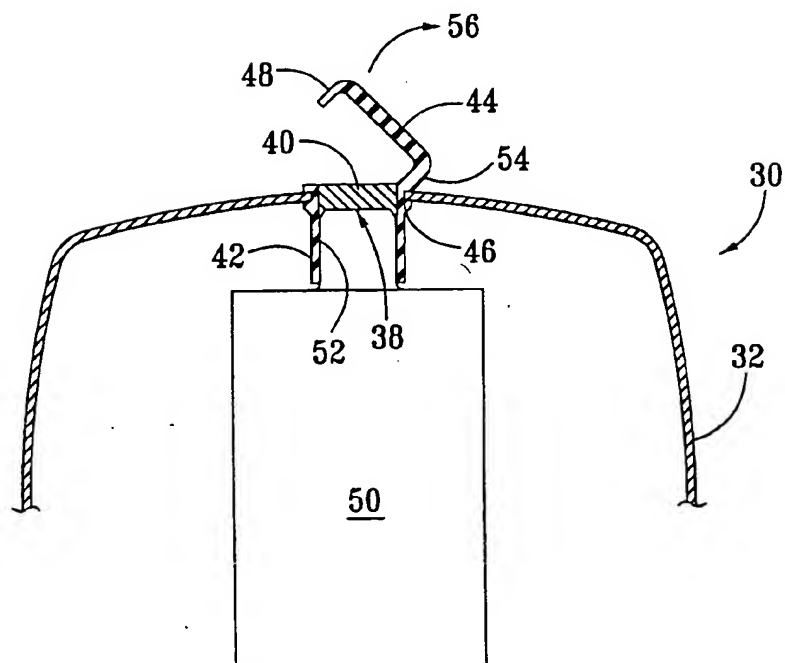


*Fig. 1*

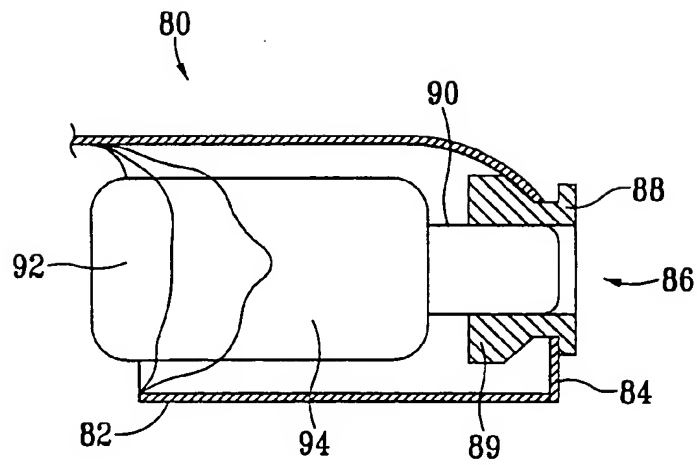
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*FIG. 2*



*FIG. 3*



*Fig. 4*

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/33150

## A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04R 25/00

US CL :381/312, 322, 324, 325

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 381/312, 322, 324, 325

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EAST

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,887,070 A (ISEBERG et al) 23 March 1999, see figures.	1-9
A,P	US 6,129,174 A (BROWN et al) 10 Oct 2000, see figures.	1-9

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

## \* Special categories of cited documents:

\*A\* document defining the general state of the art which is not considered to be of particular relevance

\*E\* earlier document published on or after the international filing date

\*L\* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

\*O\* document referring to an oral disclosure, use, exhibition or other means

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\*X\* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

\*Y\* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

\*Z\* document member of the same patent family

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